A STUDY TO ASSESS THE FUNCTIONAL AND AESTHETIC OUTCOME OF SOFT TISSUE RECONSTRUCTION OF LEG AND FOOT DEFECTS USING CONVENTIONAL AND MICROVASCULAR FREE FLAP TECHNIQUES

Dissertation submitted to

THE TAMILNADU DR. MGR MEDICAL UNIVERSITY

In partial fulfillment of the regulations for the award of the degree of

M.Ch Branch-III

Plastic Surgery

INSTITUTE OF RESEARCH AND REHABILITATION OF HAND
AND DEPARTMENT OF PLASTIC SURGERY

GOVT STANLEY MEDICAL COLLEGE AND HOSPITAL

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CERTIFICATE

This is to certify that dissertation titled "A STUDY TO ASSESS THE FUNCTIONAL AND AESTHETIC OUTCOME OF SOFT TISSUE RECONSTRUCTION OF LEG AND FOOT DEFECTS USING CONVENTIONAL AND MICROVASCULAR FREE FLAP TECHNIQUES" of Dr. S. MAHESH KUMAR in partial fulfillment of the requirements for M.Ch Branch III- (Plastic and Reconstructive Surgery) examination of the TAMILNADU Dr. M.G.R MEDICAL UNIVERSITY to be held in August 2013. The period of the study was from September 2010- August 2012

DEAN
Govt. Stanley Medical College & Hospital
Chennai 600 001.

PROF. Dr. J. MOHAN M.S, M.ch,
Professor & Head of the Department,
IRRH & Department of Plastic Surgery,
Govt. Stanley Medical College &
Hospital
Chennai 600 001.

DECLARATION

I, Dr. S. Mahesh Kumar solemnly declare that dissertation titled "A STUDY TO ASSESS THE FUNCTIONAL AND AESTHETIC OUTCOME OF SOFT TISSUE RECONSTRUCTION OF LEG AND FOOT DEFECTS USING CONVENTIONAL AND MICROVASCULAR FREE FLAP TECHNIQUES" is a bonafide work done by me at Govt. Stanley Medical College & Hospital during September 2010 to August 2012 under the guidance and supervision of Prof. Dr. J. MOHAN, M.S, M.Ch (Plastic Surgery) and Head of the Department.

This dissertation is submitted to TAMILNADU Dr. M.G.R Medical University, towards partial fulfillment of requirement for the award of M.Ch Degree (Branch-III) in Plastic and Reconstructive Surgery three years course.

Dr. S. Mahesh Kumar

Place: Chennai

Date:

ACKNOWLEDGEMENT

I owe my thanks to Professor Dr.S.GEETHA LAKSHMI, MD., Ph.D., DEAN, Government Stanley Medical College & Hospital for allowing me to avail facilities needed for my dissertation work.

I am profoundly grateful to Professor Dr. J. MOHAN, Prof & Head of the Department, Institute of Research and Rehabilitation of Hand and Plastic Surgery for his invaluable guidance in the preparation and completion of this study.

I also thank former Professor Dr. R. Krishnamoorthy, Professor Dr. J. Jagan Mohan for their valuable advices.

I thank Assistant Professors of our institute Dr. N. C. Hariharan, Dr. G. Karthikeyan, Dr. G. S. Radhakrishnan, Dr. M. Sugumar, Dr. P. Nellaiappar, Dr. M. Rajkumar, Dr. R. Sridhar for their advice and encouragement.

I am especially happy to thank my co-residents for their comments, corrections and help in the execution of this maiden effort.

I am extremely thankful to all the patients who readily consented and cooperated in the study.

INSTITUTIONAL ETHICAL COMMITTEE, STANLEY MEDICAL COLLEGE, CHENNAI-1

Title of the Work : A Study to assess the functional and Aesthetic Outcome of soft tissue reconstruction of Leg and Foot defects using conventional and microvascular Free flap Techniques - A Prospective Study

Principal Investigator : Dr.S. Mahesh Kumar

Designation : PG in M.Ch (Plastic and Reconstructive Surgery)

Department : Department of Plastic Surgery
Government Stanley Medical College,
Chennai-1

The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 06.03.2012 at the Council Hall, Stanley Medical College, Chennai-1 at 2PM

The members of the Committee, the secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

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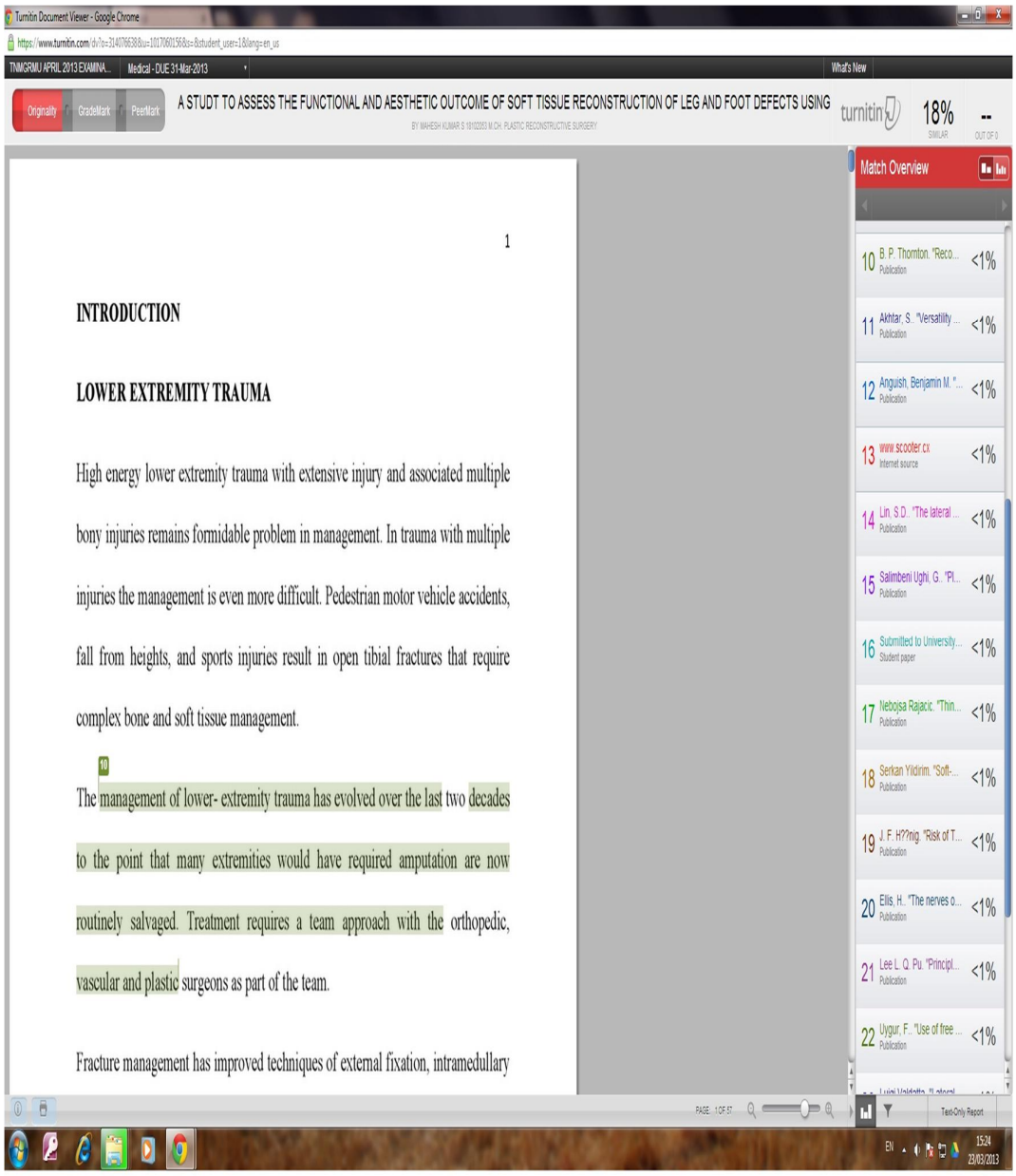
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The management of lower- extremity trauma has evolved over the last two decades to the point that many extremities would have required amputation are now routinely salvaged. Treatment requires a team approach with the orthopedic, vascular and plastic surgeons as part of the team.
Fracture management has improved techniques of external fixation, intramedullary
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INTRODUCTION

LOWER EXTREMITY TRAUMA

High energy lower extremity trauma[1] with extensive injury and associated multiple bony injuries remains formidable problem in management. In trauma with multiple injuries the management is even more difficult. Pedestrian motor vehicle accidents, fall from heights, and sports injuries result in open tibial fractures that require complex bone and soft tissue management.

The management of lower- extremity trauma has evolved over the last two decades to the point that many extremities would have required amputation are now routinely salvaged. Treatment requires a team approach with the orthopedic, vascular and plastic surgeons as part of the team.

Fracture management has improved techniques of external fixation, intramedullary rodding and internal plating, bone grafting. Soft tissue management includes grafts, local muscle flaps, fascio-cutaneous flaps and micro vascular free flaps.

The goal in treatment of open tibial fractures and lower extremity salvage is to preserve a limb that will be more functional than if it is amputated. Patients must be made aware of the expected course and anticipated functional outcome.

AIMS OF THE STUDY

- To analyze the various sites of leg and foot defects.
- To study different age and sex distribution.
- To study various types of flaps done under each category of conventional and microvascular techniques.
- To analyze the functional assessment and esthesis of reconstruction in two methods.
- To study the complications.

MATERIALS AND METHODS

All the patients who reported to the plastic surgical department, Govt. Stanley Medical College Hospital, who were presented with soft tissue defects of leg and foot were included in the study.

The period of study: September 2010 to August 2012.

The patients were referred from orthopedic, general surgery or came directly to plastic surgery department.

All soft tissue defects of leg and foot due to trauma reconstructed using conventional and microvascular free flap techniques are included.

Injuries to leg and foot with bone/ tendon/ nerve loss needing composite reconstruction are excluded.

All the patients were analyzed according to the nature of injury, age and sex distribution, sites of defects, investigations and treatment planning. On follow up they were analyzed for functional outcome by Gait analysis, Range of movements, sensibility and aesthesis.

The duration of time for return to work after reconstruction was analyzed in both forms of reconstruction.

REVIEW OF LITERATURE

HISTORY

The history of lower extremity reconstruction before world war was I is essentially the history of amputation. Hippocrates (460- 370 BC) described amputation as the method of last resort when faced with ischaemic gangrene. Celsus (25 BC- 50 AD) introduced the rules of wound management, with removal of all foreign bodies and hemostasis. Ambroise Pare (1509 - 1590) described and performed the basic rules of amputation, including refinement of amputation by amputating through viable tissue, revision of an amputation for better prosthetic fitting.

John Hunter (1728- 1793) described primary amputation only for severe inuries. Pierre- Joseph Desault (1744- 1795) coined the term debridement in the treatment of traumatic wounds. Ollier (1830- 1900) introduced the concept of immobilization and developed plaster cast.

The aseptic technique by Joseph Lister[2] (1827 - 1912) decreases the wound complications in lower extremity trauma. With the improved casualty evacuation, management of shock, use of blood transfusions, antibiotics the mortality of wound complications decreased from 8% in World War I to 4.5% in World War II. The incidence of post fracture

osteomyelitis decreased from 80% in World War I to 25% in World War II.

In the 1960's plastic surgeons discovered the transfer of regional flaps to cover the soft tissue defects of lower extremity. With the advent of microsurgery in the 1970's improved techniques of bone coverage with soft tissue and of nerve repair further advanced the ability to salvage traumatic lower extremity injuries. The concept of negative pressure dressings in 1990's by Argenta[3] further improved the wound management in lower extremity trauma.

ANATOMY

The anatomy of the lower leg and the pattern of common injuries and wound present certain unique problems for the reconstructive surgeon. (Mathes)[4].

Two lower extremities support full weight bearing in exact positions in humans. The legs support full force of the weight of the body. The inversion and eversion , plantar flexion and dorsiflexion movement of the ankle are provided by the muscles of the leg.The knee extension and flexion, toe flexion movements are also provided by the leg muscles.

The functional needs of the leg muscles would be unnecessary and generally tolerated, if the ankle were fused. A significant functional

muscle loss of can be tolerated and bipedal ambulation will be maintained . Therefore loss of leg muscles is not a major contraindication to soft tissue reconstruction and limb salvge.

The edema, deep venous thrombosis and venous stasis problems of the leg are due to imposing hydrostatic pressure .In upper extremities these problems are rare. These problems are very common in lower extremities due to its dependent position.

The atherosclerosis is much more commonly affects in lower extremity than the upper extremity. In the lower limb reconstructive procedures the vascular properties must be considered.

The skin and subcutaneous fat occupy largely in the anteromedial portion of the tibia. The unprotected anatomy of the anterior portion leads to bony exposure in many instances .So it requires specialized soft tissue reconstruction.

As the full force of the body is given to the feet, plantar sensation of the foot is vital for normal ambulation .The normal plantar sensation is required for protection of the vulnerable pressure- bearing aspect of the foot.

The relative contraindication for lower limb salvage would be loss of posterior tibial nerve with loss of plantar sensation.

Many patients with peripheral neuropathy would be able to ambulate and hence motivated patients can enjoy normal ambulation without the breakdown of soft tissue.

BONES

The tibia and fibula are the bones of the leg .The tibia provides eighty five precent of the weight bearing capacity of the leg. The fibula provides structure for muscles and fascial attachments and significant structural aspect of the ankle joint.

The articulation of the tibia with femur at knee joint on two condyles .The tibia joins with the fibula to articulate with talus and forms ankle joint.

The tibia is a classic long bone. It has a diaphyeal shaft with thick cortical bone which surrounds marrow cavity.

The diaphyseal aspect of the tibia is described as medial, lateral, posterior surfaces. The tibial medial border is subcutaneous and is most prone for injury during trauma. The tibialis anterior muscle originates from lateral surface and it is well protected by muscles of anterior compartment. The soleus and gastrocnemius muscles protects its posterior surface.

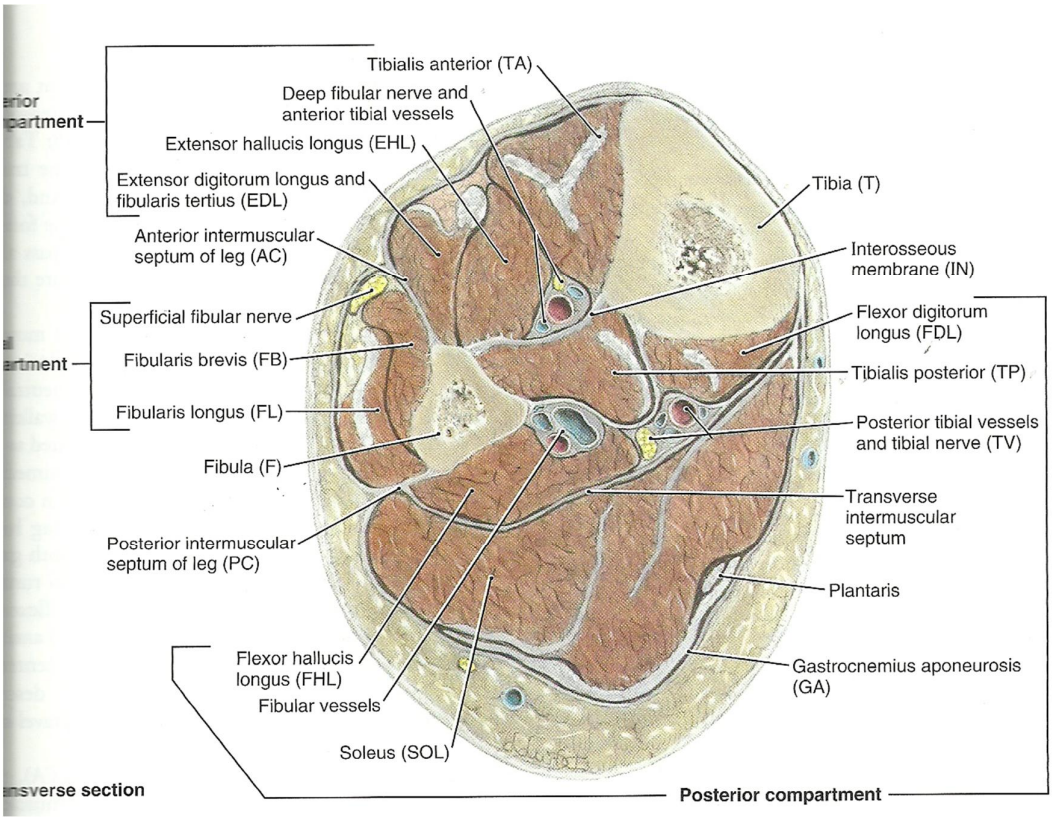
The origin of fibula is slightly posterior and is distal to tibia and also articulates with tibial posterolateral aspect. Many muscles of the leg

originate from the shaft of fibula. It articulates with the talus bone distally and form lateral malleolus.

The fibula is not weight bearing bone and hence it is in a relatively protected position and also it is less concerned in trauma. The lateral malleolus part of the fibula participates in the ankle joint and hence it is the important part of the fibula. The proximal and distal portions of the fibula are important. The blood supply to the fibula is from peroneal artery and the central portion of the fibula can be sacrificed readily due to the excellent source of vascularised long bone.

COMPARTMENTS

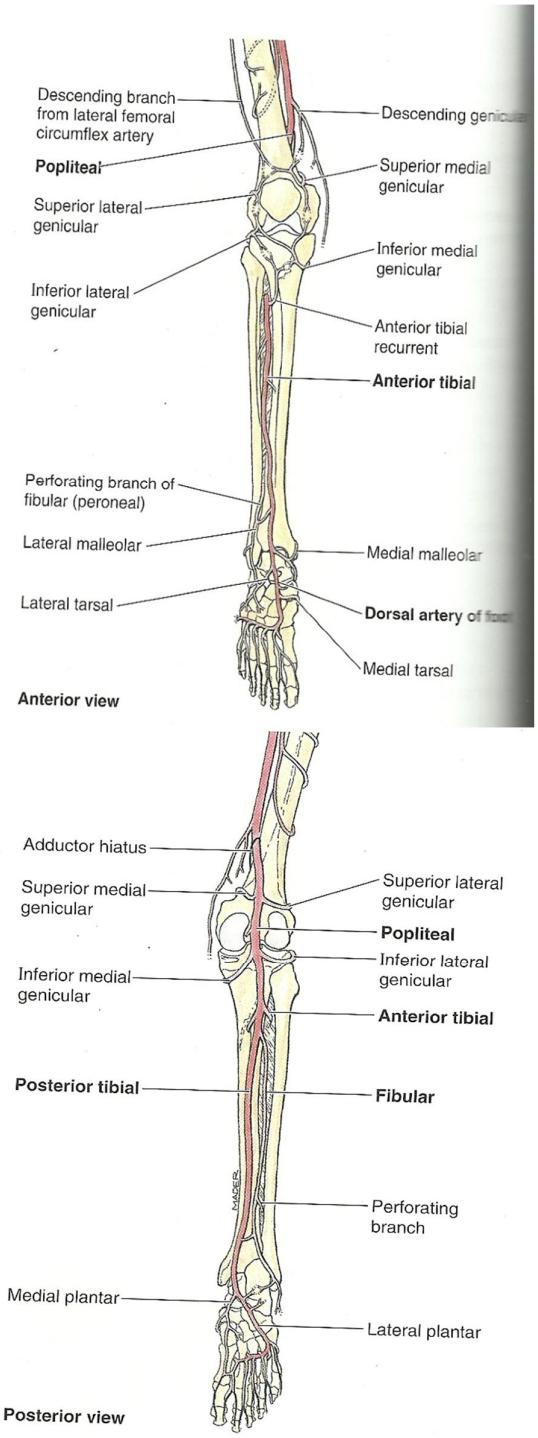
The leg muscle groups are divided into anterior, lateral, posterior and deep posterior. These muscle groups are separated by deep fascia and forming compartments.



The tibialis anterior, extensor hallucis longus, extensor digitorium longus, peroneus tertius comprises anterior compartment. The primary dorsiflexor of foot is tibialis anterior. It also inverts the foot. The extension of phalanges of the lateral four toes and dorsiflexion is by extensor hallucis longus. The peroneus tertius everts and dorsiflexes foot. The deep peroneal nerve innervates anterior compartment muscles and tibial artery provides blood supply to the muscles.

Peroneus longus and brevis muscles occupy the lateral compartment. These muscles everts and plantar flexes the foot. The superficial peroneal nerve innervates the peroneus muscles. The muscular

branches of peroneal and anterior tibial artery provide blood supply to these muscles. The gastrocnemius, soleus, plantaris and popliteus muscles occupy the superficial posterior compartment. The tibial nerve innervates all these muscles. The flexion of foot and knee is by gastrocnemius. Its vascular pedicle is by the sural branches of the popliteal artery. The soleus plantar flexus the foot. Its blood supply is from muscular branches of posterior tibial and peroneal. The plantaris provides plantar flexion which is supplied by popliteal artery branches. Popliteus plantar flexes knee and it rotates tibia and is supplied by genicular branches of popliteal.



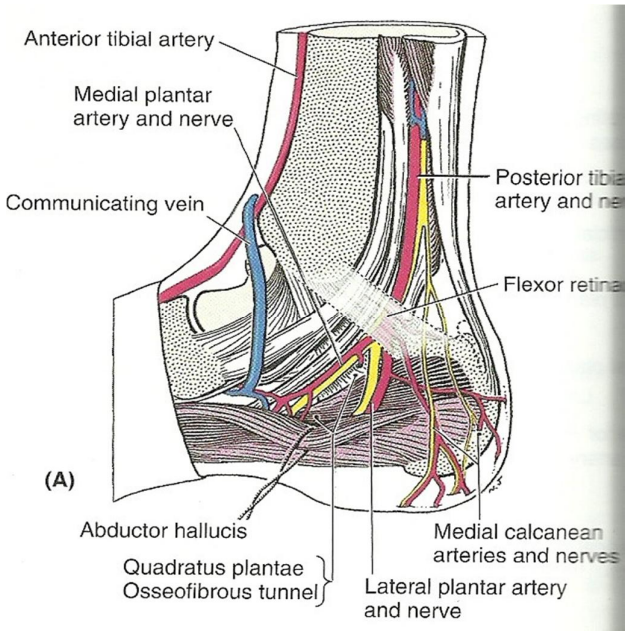
Felexor hallucis longus, tibialis posterior, flexor digitorum longus consists of deep posterior compartment. It is supplied by peroneal artery

muscle branches. The flexor digitorium longus flexes the phalanges of the lateral four toes and aids in plantar flexion of the foot.

It is supplied by posterior tibial artery. The tibialis posterior plantar flexes and inverts foot, which is supplied by muscles branches of peroneal artery.

ANATOMY OF FOOT AND ANKLE

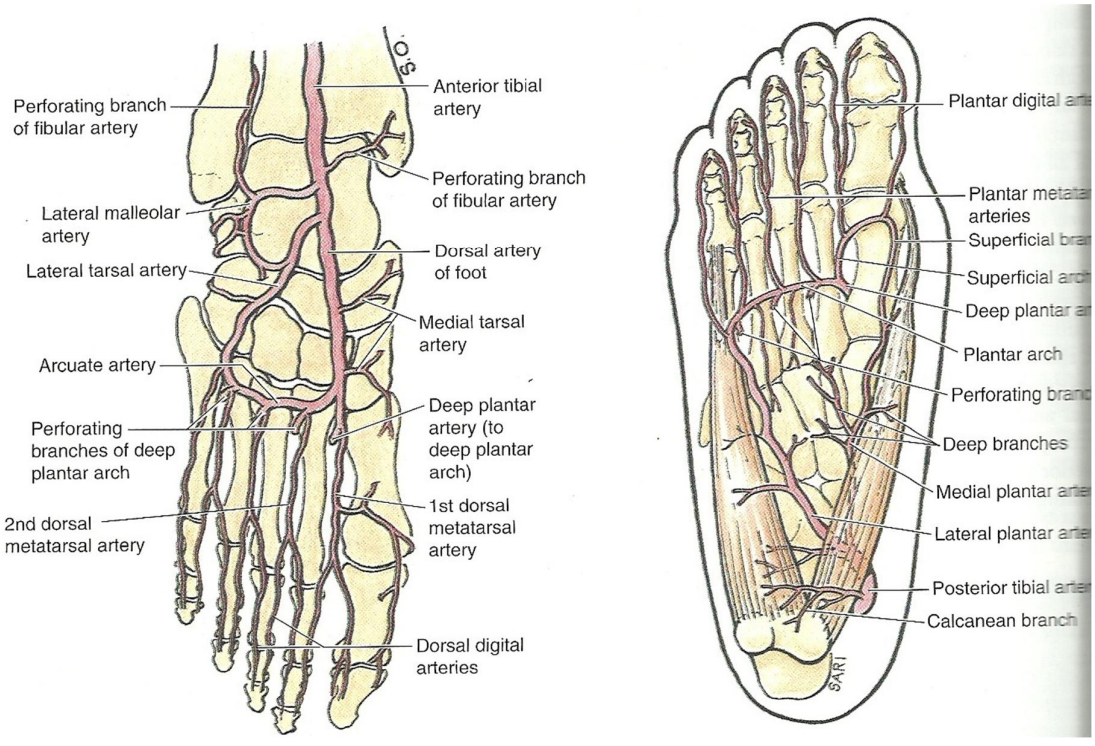
VASCULAR ANATOMY[5]



There are six angiosomes.

1. The distal part anterior tibial artery feeds anterior ankle and its continuation, the dorsalis pedis artery supplies dorsum foot.

2. Calcaneal branch of posterior tibial artery feeds medial and plantar parts of heel.
3. The calcaneal part of peroneal artery feeds lateral and plantar heel.
4. Anterior perforating branch of peroneal artery feeds anterolateral ankle.
5. Medial plantar artery supplies the plantar instep.
6. The lateral plantar artery supplies the lateral plantar mid and forefoot.



The plantar part of heel is supplied by both calcaneal branches of the posterior tibial and peroneal arteries.

The foot is rich in arterial-arterial anestomoses. At the ankle, the anterior perforating branch of peroneal artery is linked to anterior tibial artery via the lateral malleolar artery. At the lisfranc joint dorsalis pedis artery divides in the first metatarsal space to link directly with the lateral plantar artery. The plantar and dorsal metatarsal arteries in addition are linked to one another at lisfranc joint by the proximal perforators and at the web space by digital perforators.

MOTOR AND SENSORY ANATOMY

The tibial nerve innervates the muscle of superficial and deep posterior compartments (except gastrocnemius) and it ends at inner distal part ankle deep to the flexor reinaculum trifurcating into calcaneal, medial and lateral plantar nerves.

Except the extensor digitorium brevis the nerves supply motor branches to the intrinsic muscles of the foot. The deep peroneal nerve innervates the peroneal muscles and provides sensibility to lateral lower leg and dorsum foot.

The superficial peroneal nerve (L4 L5 S1) supplies anterolateral leg and exits 10 to 12 cm above the lateral ankle and travels anterior to extensor compartment and supplies dorsum foot, skin of all toes except

lateral side of fifth toe (by sural nerve) and first web space which is by deep peroneal nerve.

The deep peroneal nerve (L4 L5 S1) passes deep to extensor retinaculum to supply ankle, midfoot joints, sinus tarsi and first web space. The sural nerve along with lesser saphenous vein descends in posterior aspect of calf and provides sensibility to posterior and lateral parts of skin of leg and then to dorsolateral foot and fifth toe.

The saphenous nerve (L5, S1) a cutaneous branch of femoral nerve supplies skin of the medial half of lower leg and dorsomedial portion of the foot. The dorsum foot has communicating branches between these nerves. The calcaneal branch (S1 S2) of posterior tibial supplies medial aspects of heel pad. Lateral plantar nerve (S1 S2) provides sensation to lateral two thirds of sole and fifth and lateral fourth toes. Medial one third of sole, first second, third medial fourth toes were supplied by medial plantar nerve.

CLINICAL EXAMINATION AND INITIAL EVALUATION

The case of high energy lower extremity injuries the other life-threatening injuries are ruled out by initial evaluation. The priorities of multiple injuries are always to save the life of the patient, rather than salvage or treatment of limb. If life threatening injuries are present then the extremity injury should be limited to stabilization and control of bleeding. Initial evaluation includes both visual and manual examination.

The vascular status of the extremity is made by examination of pulses, temperature, color and turgor of the foot. Bony evaluation is made by the usual examination of open wound. Radiographs are mandatory for fracture evaluation.

Soft tissue evaluation is made by examination of skin subcutaneous tissue, muscle and periosteum. Serial debridements are necessary for avulsed soft tissues and skin flaps in the operating room. The motor and sensory neurological evaluation of peroneal and posterior tibial nerves.

The initial assessment is to evaluate whether limb is salvageable or not? If salvageable then to assess if bone, tendon, nerve reconstruction needed or revascularization is required or not? If there is need for local or microvascular flaps for soft tissue defects? The reconstructive protocol is followed if the extremity is salvageable.

RECONSTRUCTIVE PLAN

After stabilization of the patient the first step is the skeletal stabilization. After which vascular injury must be repaired if indicated. If vascularisation is done, fasciotomy should be considered for the prevention of compartment syndrome.

The debridement of nonviable tissues should be carried after initial bony stabilization. If vital structures and blood vessels exposed then soft tissue cover in the form of microvascular free tissue transter is considered. If vitals not exposed and zone of injury is not clear then multiple debridements necessary before definitive soft tissue coverage. Most authors specified that early soft tissue cover provides lower complication rate. BYRD[6] et al. found that overall complication for wounds closed in 1st week eighteen percent compared to fifty percent complication rate in sub-acute phase of 1 to 6 weeks.

In review of GODINA'S[7] work, the wounds closed within 72 hours after the injury results lowest complication rate and highest success rate.

YAREMCHUK[8] et al. believe that serial debridement of wounds is more important than the timing of soft tissue coverage.

OPEN FRACTURES OF THE TIBIA- GUSTILO CLASSIFICATION

TYPE	DESCRIPTION
I	Open fracture with a wound < 1 cm
II	Open fracture with a wound > 1 cm without extensive soft-tissue damage
III	Open fracture with extensive soft- tissue damage
III A	III with adequate soft- tissue coverage
III B	III with soft- tissue loss with periosteal stripping and bone exposure
III B	III with arterial injury requiring repair

RECONSTRUCTION OF SOFT TISSUE

SOFT TISSUE COVERAGE: The use of reconstructive ladder should be progressing from simple to more complex options. But many of lower rungs on the ladder may not be suitable options in complex lower extremity wounds which necessitates the reconstructive elevator moving up to use the most optimal reconstructive options.

The primary closure of wounds need healthy tissue and must be free of tension. On weight bearing areas the skin grafts provide poor durability

coverage. The conventional flaps and microvascular free tissue transfer were discussed according to the site of defect.

Special Problems:

The debridement of soft tissue avulsion should be carried out at the initial treatment without delay. If the extremity is ischemic then emergency angiography must be done. If the extremity is not ischemic then the angiography may be delayed after fracture fixation, wound debridement and by soft tissue cover. There are poor results in nerve repair or grafting in the lower extremity injuries. TRUMBLE[9] found that 11% average return of strength and protective sensation in all of his nine patients, most of these were in pediatric age group.

The techniques for fracture fixation available include fraction, casting/ splinting, internal or external fixation, intra-medullary nailing.

FLAPS USED FOR LEG DEFECTS

< 5cm defects upper & middle third anterolateral aspect	Fasciocutaneous flaps
Upper third defects exposing bone	Gastrocnemius muscle flap & SSG
Middle third defects with bone exposure	Soleus muscle flap & SSG
Lower third defects ankle, heel pad	Reverse Sural Artery Flap, cross leg flap
Defects just proximal to lateral malleolus	Peroneus Brevis muscle flap & SSG
For larger defects > 5cmwith bone exposure	Free Anterolateral Thigh Flap

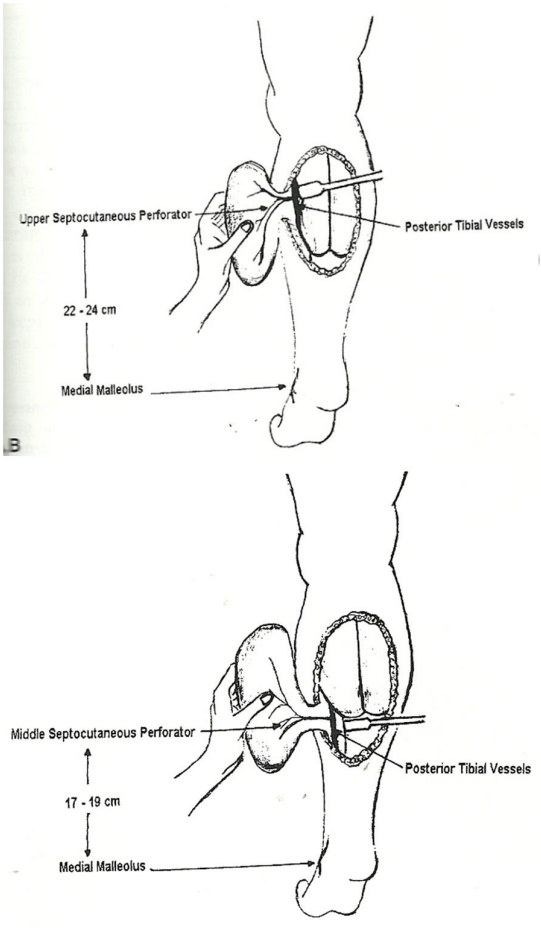
FLAPS USED FOR FOOT DEFECTS[10]

< 5cm small defects		
Defects over Calcaneum		Medial Plantar Flap
Defects over heel, medial aspect ankle joint and medial malleolus		Abductor Hallucis Muscle Flap&ssg
Posterior heel defects		Lateral Calcaneal Artery Flap
LARGER DEFECTS > 5CM EXPOSING BONE	PLANTAR	a) Free Anterolateral thigh Flap
		b) Free Latissimusdorsi flap & ssg
	DORSUM	c) Free temperoparietal fascial flap & ssg
		d) Free gracilis muscle flap & ssg

CONVENTIONAL FLAPS

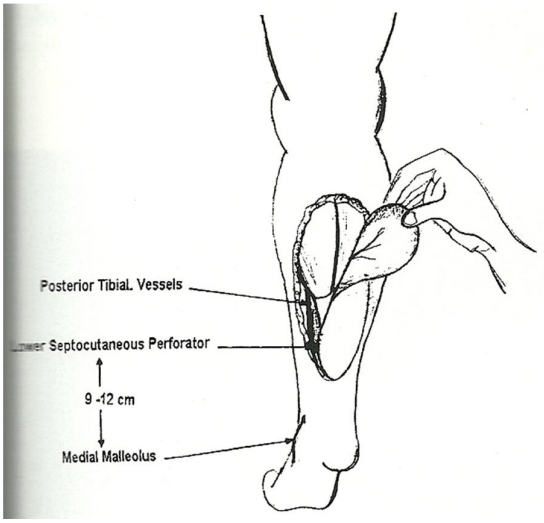
THREE ANTEROMEDIAL FASCIOCUTANEOUS LEG ISLAND FLAPS[11]

Indications : The upper middle flaps are indicated for coverage of bony and soft tissue defects of upper and middle thirds of anterolateral aspect of the leg. The lowest flap is used for coverage of medial and lateral malleolus, back of calcaneum, Achilles tendon.



Anatomy: The medial septocutaneous vessels arise from the posterior tibial vessels and are enclosed in deep transverse fascial septum. The feeding vessels of three flaps are most frequently located between 9-12 cm, 17-19 cm, 22-24 cm respectively from the tip of the medial malleolus.

Operative Techniques: The flap should be raised from its posterior edge in a subfascial plane. The pedicles will appear just before the tibial medial border. After that the flap is raised from all its edges. The greater saphenous vein should be included. The donor site is covered with SSG and flap is then transferred to resurface the defect.



Advantages: These flaps are thin, reliable and easy to elevate. The arc of rotation is extensive and the flap can fit comfortable and exactly without kinking. The operating time and donor area morbidity are less.

FASCIOCUTANEOUS FLAP

The blood supply to the fascia, subcutaneous fat, skin dependent highly on the perforating vessels from the underlying muscle.

Anatomy: There are long arteries proximally under the fascia following the axis of extremity, which eventually penetrate and creates a plexus in and on the fascia.

On the medial aspect saphenous artery and inferior genicular artery proximally, distally branches from posterior tibial artery from the longitudinal plexus over the superficial surface of deep fascia.

On the lateral aspect anterior tibial vessels with lateroposterior branches of peroneal artery from the longitudinal plexus of fascia on lateral compartment.

The fasciocutaneous[12] flaps can be elevated safely based on these septocutaneous vessels proximally or distally based.

Operative Techniques: The circulation between fascia and skin should not be disturbed. The initial incision is on the site where there is an adequate space between fascia and muscle. Through this incision the fascia can be lift in from the underlying muscle using blunt dissection. The rotation can be quite extensive, the longitudinal incision of the flap border

becomes horizontal position. The operative technique is simple and short, the flap is safe and stable.

SOLEUS FLAP

The soleus[13] muscle flap is used to cover the middle third defects of leg. Because of vascularity the muscle flaps are more effective for contaminated (or) ischemic defects.

Anatomy: The soleus muscle lies immediately beneath gastrocnemius and plantaris in the posterior compartment. It has dual neurovascular supply and has bipennate morphology. It can be split into two soleus bellies lateral and medial hemisoleus[14]. The blood supply is provided by popliteal, posterior tibial and peroneal vascular pedicles.

The pivot point for soleus muscle flap is at the function of proximal and middle thirds of the leg. For revised medial hemisoleus and soleus muscle flap the pivot point is two most distal posterior tibial pedicles.

Operative Techniques: The approach is either medial or lateral midline incision in posterior compartment. The mid-section leg where well defined planes usually separate soleus from overlying gastrocnemius tendon. The vascular pedicles from peroneal and posterior tibial cross deep plane. The soleus muscle may be designed into proximally based or hemisoleus or reverse flaps.

GASTROCNEMIUS MUSCLE FLAP

The gastrocnemius[15] muscle or musculocutaneous flap is highly effective in the management of knee and upper leg defects. The medial head of gastrocnemius is largely or longer and it covers wounds of upper third tibia. As a musculocutaneous flap it can cover upper two thirds of tibia, knee and lower thigh.

Type I muscle by Mathes & Nahai classification.

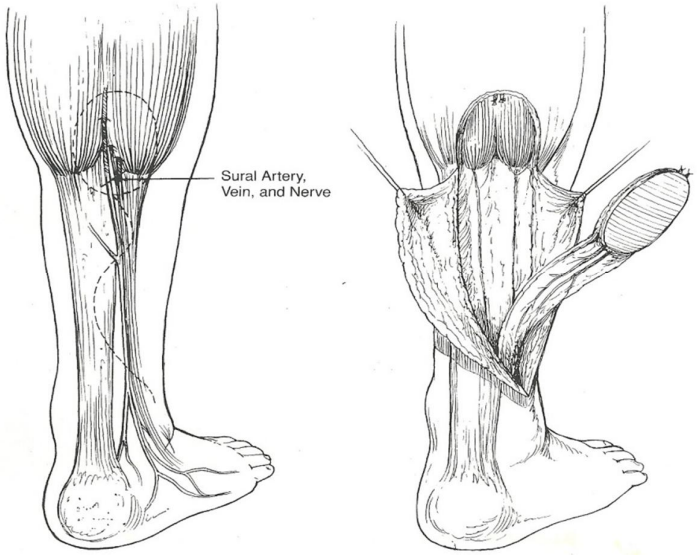
Anatomy: The gastrocnemius is the superficial muscle in the posterior compartment. It has both medial and lateral heads. The tendon of gastrocnemius joins with soleus to from the Achilles Tendon. Gastrocnemius plantar flexes foot and also flexes the knee joint.

The blood supply is by medial and lateral sural arteries. Both vessels arise from popliteal artery above the knee joint.

Operative Technique: Posterior dissection done first through a longitudinal or posterior midline incision between the midline and defect. The two key landmarks are sural nerve and lesser saphenous vein. The gastrocnemius muscle fascia is split and the junction of two heads is incised. The plane between gastrocnemius and soleus should be created by blunt dissection. The muscle is transected distally with a cuff of tendon for its fixation to the wound edge. The split skin graft can be used to cover the muscle flap.

REVERSE SURAL ARTERY FLAP[16]

Indication: It is used to reconstruct the posterior aspect of heel and Achilles tendon, anterior and lateral parts of ankle, dorsum foot, anterior aspect of lower third leg.



Anatomy: Sural artery arises from the popliteal artery. Along with sural nerve it courses between the heads of gastrocnemius and it passes the lateral edge of Achilles tendon. It supplies skin of lower and middle posterior leg. The sural nerve along with lesser saphaneous vein innervates lateral side foot and fifth toe. A large perforator approximately 5 cm proximal to lateral malleolus is present which is more reliable and is the pivot point of pedicle.

The skin paddle is marked on the posterior aspect of calf at the function of heads of gastrocnemius. The pedicle should include

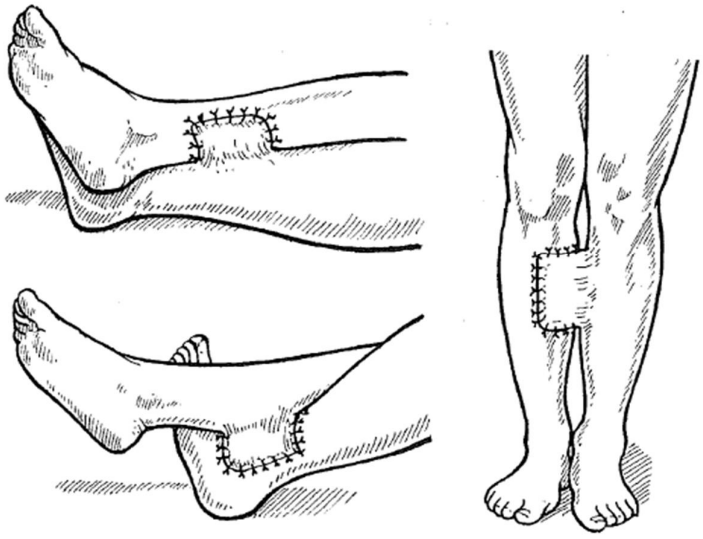
adipofascial tissue, subdermal tissue, sural nerve and short saphenous vein and deep fascia.

The length to width of pedicle is approximately 4: 1

Operative Technique: A prone position is preferred if the defect is on the posterior aspect heel or lateral ankle. The flap is marked and pivot point marked with dopper ultrasound. Incision made and skin flaps raised subdermally upto pivot point. The flap with fascia, lesser saphenous vein, sural nerve raised upto pivot point. Flap rotated to cover the preferred defects. The donor area covered with skin graft. Postoperative care is essential and excessive pressure on pedicle or flap is avoided.

CROSS- LEG SKIN FLAP

The cross leg flap[17] is a bridge flap from one tower extremity to the other. It is a standard method which provides skin flap to resurface method which provides skin flap to resurface defects of lower limb.



The discovering of newer faciocutaneous, muscle flaps have given rise to much precise in planning safer cross-leg flaps, in addition to random pattern cross leg flap.

Indications: The main indication for the cross leg flap is to resurface the defects on leg, ankle or foot with exposed underlying bones or tendon. This technique needs meticulous planning, 3 weeks of immobilization, staged procedures. The amount of skin available is large and is used for most defects of lower limb.

The flap is contraindicated in patients with joint stiffness and in old ages.

Anatomy: Vascular supply is derived from underlying arteries and muscles in perforating branches. It includes fascial plexus as well as subdermal plexus.

Flap Design: The principal donor site is calf. Flaps raised along with fascia have better blood supply. The proximally based flaps have better blood supply than the distally based flaps. Transverse flaps on the anterior region medial calf must be atleast 3 cm behind the tibial medial border[18]. The flap with short bridge avoids kinking (or) twisting of the flap. Crossed leg flap should be avoided.

The skin graft is applied to donor site and bridge segment. Accurate fixation avoids the tension or kinking of the bridging segment. The plaster of paris casts is placed preoperatively with windows or at the time of operation. The flap division is performed at 3 weeks. After the division the patient is mobilized with increasing limb dependency. Elastic compression bandage is important in the early weeks.

PERONEUS BREVIS MUSCLE FLAP[19]

Indication: It can be used to cover defects just proximal to the lateral malleolus.

Anatomy: It arises from the fibula in its lower lateral surfaces and from intermuscular septum. It lies between extensor digitorum longus anteriorly and flexor hallucis longus posteriorly.

The vascular supply is by segmental branches from peroneal artery. The nutrient vessels from anterior tibial artery supplies upper part of muscle. The nerve supply is from superficial peroneal nerve.

Operative Techniques: The incision is longitudinal made on the posterior border of lateral malleolus. The muscular attachment to the fibula can be released distally up to 10 to 12 cm. the peroneus brevis tendon is transected distally and transferred to the defect.

MEDIAL PLANTAR FLAP:

The medial plantar flap[20] is used for coverage of defects over the calcaneum. The plantar concavity derives its sensory innervations from fourth and fifth lumbar nerve roots. The medial plantar nerve & artery can be used in the design of a plantar transposition flap for restoring sensation to heel surfaces.

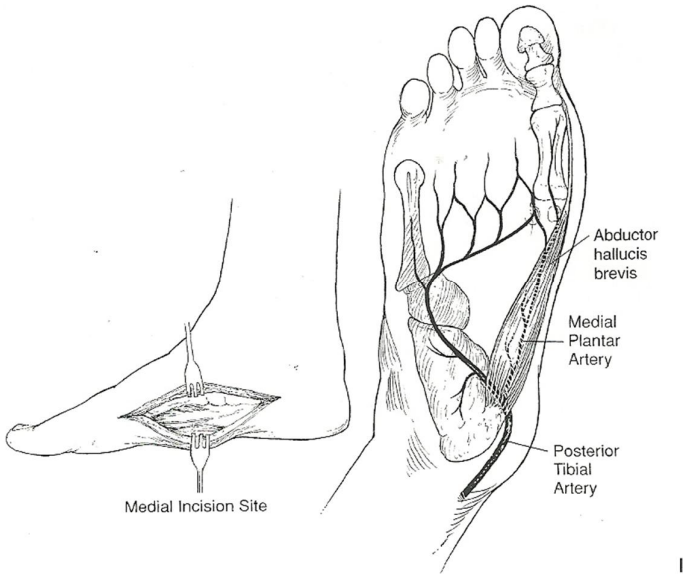
Anatomy: The medial plantar artery, branch of posterior tibial artery arises behind abductor hallucis origin and it passes deep to plantar fascia. It supplies skin of the medial two thirds of plantar concavity. The medial plantar nerve a branch from tibial nerve accompanies medial plantar artery. Its sensory branches perforate plantar fasciae and supplies medial two thirds of non-weight bearing area.

Operative Techniques: Using doppler the patency of medial plantar artery is verified. Distal incision made first. Skin deepened up to plantar fascia. Digital branches of artery are divided proximally plantar cutaneous branch separated. Abductor hallucis is divided at its insertion for mobilizing of flap. The great saphenous vein is preserved for venous out flow. The flap is transferred and the donor site is resurfaced with skin graft.

ABDUCTOR HALLUCIS MUSCLE FLAP

It can be used to cover the defects over heel, medial aspect of ankle joint and medial malleolus.

Anatomy: The muscle arises from medial process of calcaneus. The tendon inserts into proximal phalanx of big toe. The blood supply is by medial plantar artery and nerve supply is by medial plantar nerve.



Operative Technique:

The muscle is exposed after making incision just above medial border of sole of foot. The tendon is divided at metatarsophalangeal joint, medial border of the muscle is mobilized first and then lateral border is mobilized till the neurovascular bundle is located. The abductor hallucis[21] muscle is used to cover defects from heel to medial malleolus areas.

LATERAL CALCANEAL ARTERY SKIN FLAP

It is an extremely reliable flap used to provide sensate flap for covering posterior heel.

Anatomy: The lateral calcaneal skin flap[22] is an axial pattern flap. The vascular pedicle is lateral calcaneal artery, lesser saphaneous vein and sural nerve. Lateral calcaneal artery is terminal branch of peroneal artery. The Doppler probe is most useful to determine the pateny of calcaneal artery.

Flap Design: The vertical distance between the lateral malleolus and plantar surface of heel is completely axial pattern. The flap extension is upto 6 cm more distally by including random portion of tissue proximal to base of 5^{th} metatarsal. The pedicle of flap lies immediately above the level of lateral malleolus. The base of the flap is atleast 4 cm circle.

Operative Technique: Dissection should be started at the lateral aspect of calcaneal tendon and distally upto periosteum of os calcis. The periosteum should be intact. The anterior incision made behind lateral malleolus and through subcutaneous tissues. The flap should be mobilized in a retrograde fashion. Flap rotated to defect and inset given. Reliable flap for older & diabetic patients.

FREE FLAPS

ANTEROLATERAL THIGH FLAP

Skin Sqcm	Bone cms	Muscle	Subcut ccm	Fascia	Pedicle cms	Donor site morbidity
750	Nil	Vastus lateralis	1.5-3 cm	Deep fascia of thigh	8 to 10	Scar of surgery / skin graft

Versatile soft tissue flap. Skin paddle available is the largest, up to 25 X 30 centimeters in adult. As a pedicle flap it can reach lower abdomen, perineum, groin and buttock region. Donor site morbidity is very low. ALT can be used as a chimeric flap. i.e vastus lateralis muscle on one branch and skin on separate perforator. Donor site morbidity is very low.

Contraindication: Very fat thigh.

Anatomy: The anterolateral thigh flap[23] is a fasciocutaneous flap based on the septocutaneous or musculocutaneous perforators of the descending branch of the lateral circumflex.

A satisfactory perforator is generally found within 3 cm of the midpoint of a line connecting the anterior superior iliac spine with the superolateral border of the patella. More half than of perforators traverse the substance of the vastus laterials muscle. The descending branch of the lateral circumflex femoral artery, and its venacomitants, lie between the vastus lateralis and rectus femoris muscle.

Operative Procedure

Keep leg in straight position, no internal or external rotation. Find the usual location of perforators. Draw a circle of 3 centimeter radius at midpoint on the line joining anterior superior iliac spine and supero lateral border of patella. Identify cutaneous perforators with hand held Doppler along line/ circle. Mark skin paddle length and width as per defect. Design an elliptical flap, include the main perforator area.

Take the medial skin incision first. Incise and tag deep fascia to skin with few interrupted sutures to avoid shearing of perforators. Rectus femoris muscle is identified easily with its bipinate nature and inverted ‘V’

look. Raise fascia off rectus femoris muscle and identify septum between vastus lateralis and rectus femoris muscle.

Look for perforators, both direct septocutaneous or musculo cutaneous. Dissect musculo cutaneous perforators carefully through muscle up to the main pedicle. Take lateral skin incision through the fascia lata, tag fascia to skin with suture. Start from below upwards, dissect the fascia lata (and skin paddle) off the underlying vastus lateralis muscle until the inferior- most perforator is reached.

Dissect this perforator from its surrounding muscle with careful dissection. If a single perforator is to be used, a small cuff of muscle should be left adherent to it, in order to avoid twisting of the pedicle. This is not necessary if two perforators are included in the flap.

Dissect remaining perforators in the same manner as the first. Dissect the descending branch of the lateral circumflex femoral artery and vein superiorly to their branches to the rectus femoris, which should be preserved. Verify perfusion through the perforators by checking for bleeding at the cut skin edges of the flap.

Clip and divide the pedicle. Undermine medially and laterally in the suprafascial plane for closure of wound. Do not make an effort to re-approximate fascia lata. Place suction drain. Close the skin in two layers,

with 2-0 Vicryl in the dermis followed by interrupted skin suturing using 3-0 ethion or stapler. The skin paddle can be made much larger as per requirement of the defect, and may require skin graft for closure.

FREE LASTISSIMUS DORSI FLAP[24]

It is harvested as either a muscle or musculocutaneous flap. It is type V flap. The dominant vascular pedicle is thorocodorsal artery. The minor pedicles are medial and lateral row of posterior intercostals & lumbar perforators. The muscle is innervated by thorocodorsal nerve. The sensory innervation is from intercostal nerve.

It can be used as a pedicle flap, functional flap and as a free flap. As a free flap it can be used for coverage of scalp and extremities. The skin island is marked if required. The vascular pedicle is marked in posterior axilla entering lateral part of muscle which is 15 cm below humeral insertion. The skin incision made. The lastissimus muscle fibers are identified and separated superiorly from scapula and trapezius. Vertebral attachments are divided. The direction of dissection is then towards the axilla and near the pedicle. The pedicle can be easily achieved if the muscle is used as a free flap once the branches to serrtates divided.

TEMPOROPARIETAL FASCIAL FLAP

The temporoparietal flap[26] provides a thin well- vascularized fascial flap that is easily rotated to cover orbital defects extending to the nose, cheek defects extending to the oral commissure, and intraoral defects over the body of the mandible. The flap readily accepts a skin graft. If required, the flap may be harvested with an outer table cranial bone component as a composite flap.

Anatomy: The temporoparietal fascia is continuous with the SMAS inferiorly and the galea superiorly. The transition from temporoparietal fascia to galea occurs in the region of the temporal line. Above the temporal line, the fibrous connections between the dermis and fascial layer become more numerous making dissection somewhat more tedious. The temporoparietal fascial plane lies just below hair follicles in the subcutaneous tissue and superficial layer of the deep temporal fascia below the temporal line.

The superficial temporal artery runs within the fascia in an axial pattern. The superficial temporal veins tend to run on the outer surface of the fascial layer, and they are much more prominently visualized during harvest. A well- defined fascial plane with a visible axial blood supply is present for approximately 12 cm above the root of the helix. Anteriorly, the frontal branch of the facial nerve runs on the undersurface of the

temporoparietal fascia. The structure delimits the anterior margin of the flap.

Flap Harvest:

Flap is raised as fascia only. Mark incision starting from preauricular region at zygomatic arch extending above in a curvilinear fashion upto just beyond temporoparietal region. Feel superficial temporal artery and mark its course. Incise skin upto the level of hair follicles. Dissect in this plane anteriorly, posteriorly and superiorly towards temporoparietal line. Take care not to damage hair follicles. Look for superficial temporal vessels. An average flap measures 12cm in length and 14 cm in width. Dissect superficial temporal vessels and taper flap towards zygoma. To increase its size include galea aponeurotica and pericranium in the flap. If required harvest vascularised bone segment in region of superior temporal fossa. Divide fascia along the periphery. Elevate flap from deep temporal fascia in cephald to caudal direction upto zygoma. Ligate frontal and deep temporal branches. A loose areolar a vascular plane facilitates dissection. Observe fascial flap for perfusion. Transfer as pedicled flap or divide it for free transfer. Keep suction drain in wound. Close donor area after haemostasis.

GRACILIS FLAP

The gracilis flap[25] is harvested as either muscle or musculocutaneous flap. It is type II flap. The dominant vascular pedicle is ascending branch of the medial circumflex femoral artery. The first and second branches of superficial femoral artery are the minor pedicles. The gracilis muscle is innervated by the anterior branch of the obturator nerves. The gracilis muscle flap serves as a functional flap for facial reanimation. It is used as a free flap for the coverage of head and neck and extremities.

Surgical Techniques:

A linear incision is made 2-3 cm posterior to the line which connects the pubis and medial condyle. The gracilis is posterior to adductor longus. The musculotendinous insertion lies posterior to Sartorius and sapheneous vein. The tendon is isolated and then divided. The minor pedicles are divided when dominant pedicle is chosen.

The exposure of dominant pedicle is by the medial retraction of adductor longus. After passing over adductor magnus the pedicle enters the gracilis on the deep surface about 10 cm inferior to pubic tubercle. In case of free flap if additional pedical length is required then pedicle is dissected proximally after dividing branches to adductor magnus and longus muscles.

The skin island if required should be vertical or horizontal ellipse. The skin island is incised from distal to proximal down to the level of fascia. The gracilis musculocutaneous flap does not have a robust and reliable skin paddle.

FUNCTIONAL ASSESSMENT

POSTURE AND GAIT

The lower limbs function primarily in standing and walking.

STANDING AT EASE

When a person is standing at ease with the feet slightly apart and rotated laterally so the toes point outward, only a few of the back and lower limb muscles are active. In the stand- easy position, the hip and knee joints are extended and are in their most stable positions. The ankle joint is less stable than the hip and knee joints, and the line of graving falls between the two limbs just anterior to the axis of rotation of the ankle joints.

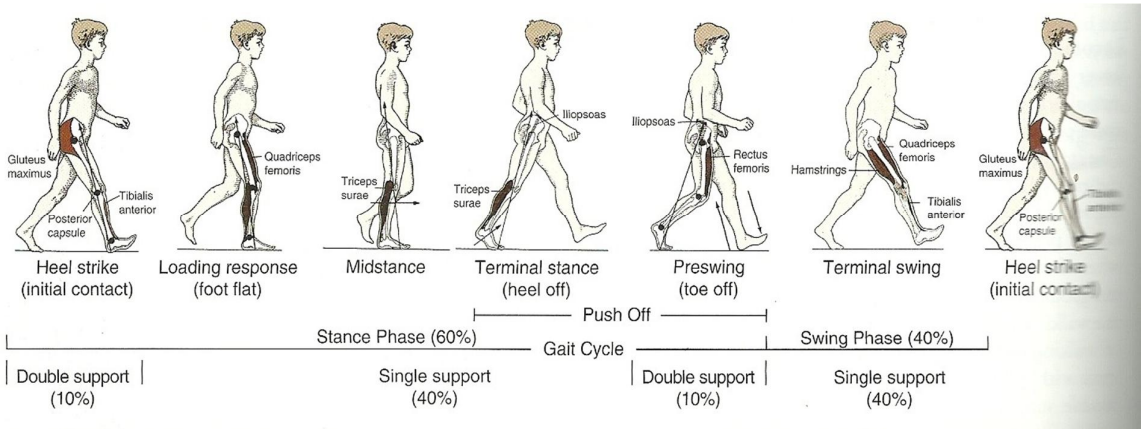
The forward sway is countered periodically by bilateral contraction of calf muscles (Plantar Flexion).

The spread and splay of the feet increase lateral stability. The lateral sway is countered by the hip abductor, fibular collateral ligament of knee joint, and the evertor muscles of one side acting with the thigh abductors, tibial collateral ligament, and invertor muscles of the contralateral side.

WALKING: THE GAIT CYCLE

The movements of the lower limbs during walking on a level surface may be divided into alternating swing and stance phases.

The gait[28] cycle consists of one cycle of swing and stance by one limb.



The stance phase begins with heel strike, when the heel strikes the ground and begins to assume the body's full weight and ends with push off from the forefoot- a result of plantarflexion. The swing phase begins after push off when the toes leave the ground and ends when the heel strikes the ground. The swing phase occupies approximately 40% of the walking cycle and the stance phase 60%.

The stance phase of walking is longer than the swing phase because it begins and ends with relatively short periods (each 10% of cycle) of double support (both feet are contacting the ground) as the weight is

transferred from one side to the other, with a more extended period of single support in between as the contralateral limb swings forward.

Concentric hip flexion and knee extension are used during the swing phase of level walking and so are not weights bearing actions.

The invertors and evertors of the foot are principal stabilizers of the foot during the stance phase.

MOVEMENTS

A. MOVEMENTS OF THE ANKLE JOINT

The main ankle joint movements are dosiflexion and plantar flexion of the foot[27]. These movements occur around the transverse axis passing through talus. Dorsiflexion is produced by muscles in anterior compartment of leg.

MUSCLE	INNERVATION	ACTION
Tibialis anterior Extensor digitorum longus Extensor hallucis longus Peroneus tertius	Deep peroneal nerve (L4, L5)	Dorsiflexes ankle and inverts foot Extends lateral 4 digits and dorsiflexes ankle Extends great toe and dorsiflexes ankle Dorsiflexes ankle
Lateral Compartment Peroneus Longus Peroneus Brevis	Superficial Peroneal Nerve (L5, S1, S2)	Everts foot and weak plantar flexion

The plantar flexion is produced by muscles in Posterior Compartment of leg

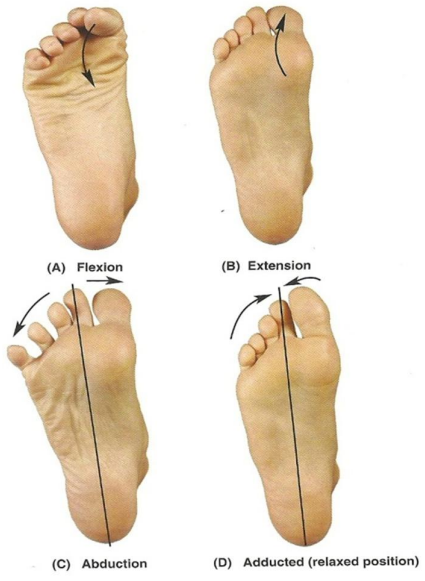
MUSCLE	INNERVATION	ACTION
Gastrocnemius		Flexes leg at knee joint, plantar flexes ankle when knee is extended, raises heel during walking.
Soleus	Tibial Nerve (S1, S2)	Plantar flexes ankle, steadies leg on foot
Plantaris		Weakly plantar flexing ankle

MUSCLE	INNERVATION	ACTION
Popliteus	Tibial Nerve (L4, L5, S1)	Weekly flexus knee and unlock it by rotating femur 5 degree on fixed tibia, medially rotates tibia.
Flexor hallucis longus	Tibial Nerve (S2, S3)	Flexes great toe at all joints, weakly plantar flexes ankle support medial longitudinal arches of foot.
Flexor digitorum longus		Flexes lateral four digits, plantar flexes ankle, supports longitudinal arches of foot.
Tibialis Posterior	Tibial Nerve (L4, L5)	Plantar flexes ankle and inverts foot.

FOOT JOINTS AND MOVEMENTS

JOINT	MOVEMENTS
Subtalar	Inversion and eversion of foot
Talocalcaneonavicular	Gliding and rotatory movements
Calcaneocuboid	Inversion and eversion of foot; Circumduction
Tarsometatarsal	Gliding and Sliding
Intermetatarsal	Little individual movements
Metatarsophalangeal	Flexion, Extension, Abduction, Adduction and Circumduction
Interphalangeal	Flexion and Extension

MOVEMENTS OF JOINTS OF FORE FOOT



MOVEMENTS	MUSCLES
METATARSOPHALANGEAL JOINTS	
Flexion	Flexor digitorum brevis Lumbricals Interossei Flexor hallucis brevis Flexor hallucis longus
Extension	Extensor hallucis longus Extensor digitorium longus Extensor digitorium brevis
Abduction	Abductor hallucis Abductor digiti minimi Dorsal interossei
Abduction	Adductor hallucis Plantar interossei

INTERPHALANGEAL JOINTS

Flexion	Flexor hallucis longus Flexor digitorum longus Flexor digitorum brevis
Extension	Extensor hallucis longus Extensor digitorum longus Extensor digitorum brevis

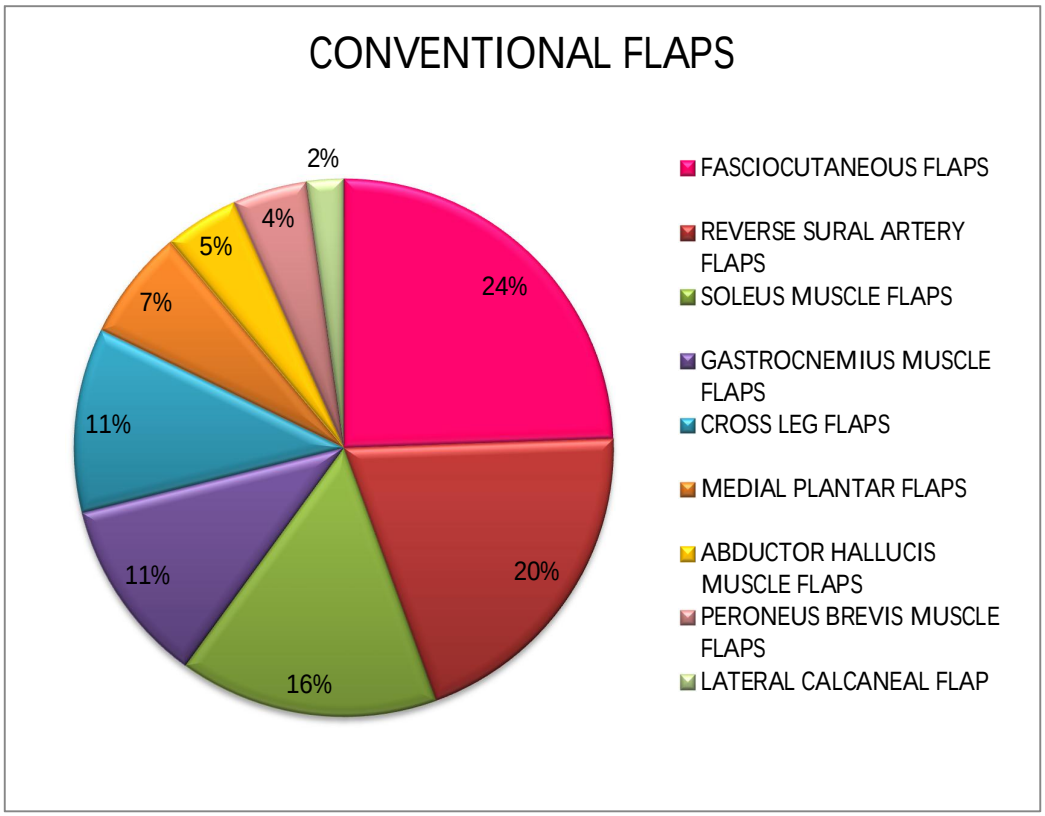
CUTANEOUS INNERVATION OF FOOT

- Medial aspect by saphenous nerve and it extends distally to the head of 1st metatarsal.
- Superior aspect is dorsum of foot is by superficial peroneal nerve and also by deep peroneal nerve.
- Inferiorly the sole of foot is innervated by medial and lateral plantar nerves. The common border of the distribution extends in the 4th metatarsal.
- Lateral aspect by sural nerve, which includes parts of heel.
- Posterior aspect, the heel is by calcaneal branches of tibial and sural nerve.

Aesthesis is assessed by means of the color matching of the flap related to the adjacent areas of defect and texture of the flap with the surrounding skin surface and finally the contour suitable for the size of defect.

ANALYSIS

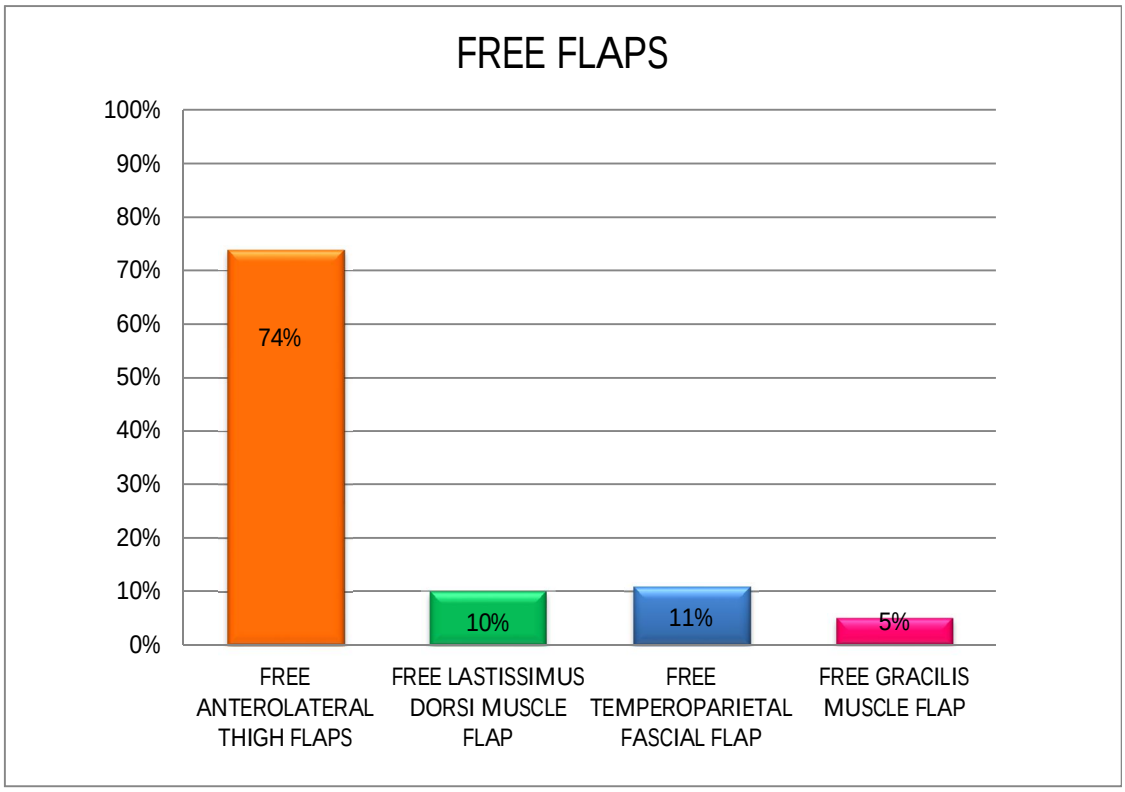
Total number of reconstructive flaps used were 64 of which conventional flaps 45 and free flaps 19.



FREE FLAPS

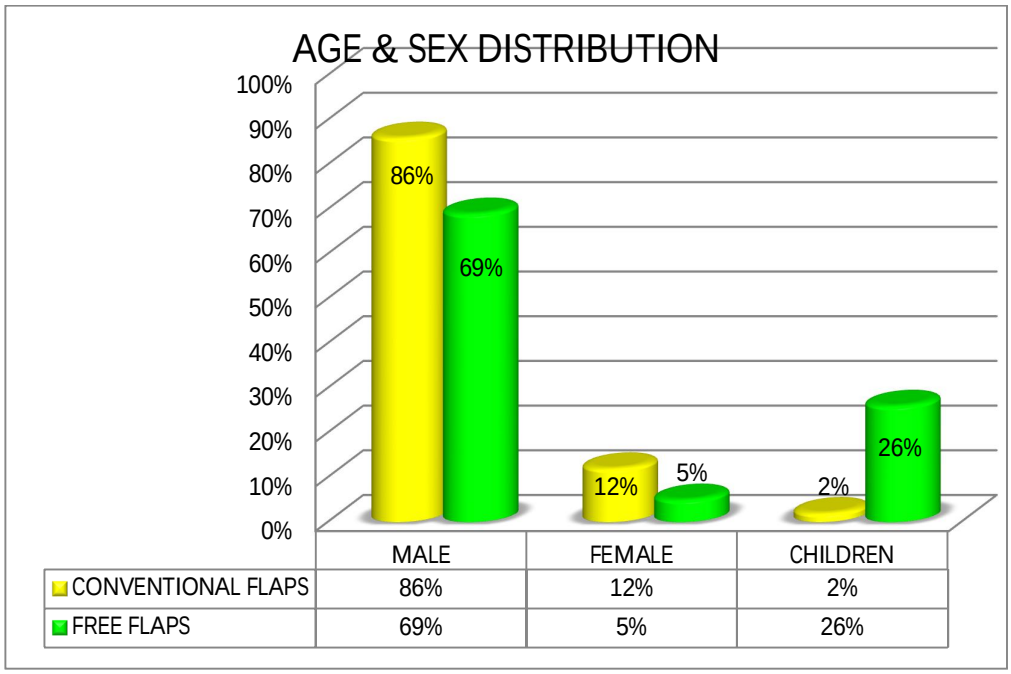
There were totally 19 free flap cases done for leg and foot defects, of which free anterolateral thigh flap was given for 6 foot defects and 8 leg defects. Free latissimus dorsi muscle flap , Free Temperoparital fascial flaps given for 2 foot defects each. Free gracilis muscle flap and SSG given for one foot defect.

Free gracilis muscle flap and free temporoparietal fascial flaps given for dorsum foot defects. Free latissimus dorsi muscle flap was given plantar and dorsum foot defects each. The free anterolateral thigh flap was given for five cases of dorsum foot defects one case of plantar defect.



VARIOUS SITES FOR RECONSTRUCTIVE FLAPS

		CONVENTIONAL FLAPS	FREE FLAPS
LEG DEFECTS	UPPER 1/3	8	
	MIDDLE 1/3	13	3
	LOWER 1/3	16	5
FOOT DEFECTS	DORSUM	2	9
	PLANTAR	6	2
TOTAL		45	19



CONVENTIONAL FLAPS USED FOR LEG AND FOOT DEFECTS

	Fascio Cutaneous Flap	**Reverse Sural Flap**	**Soleus Muscle Flap**	**Gastrocnemius Muscle Flap**	**Peroneus Brevis Flap**	**Cross Leg Flap**	**Abductor Hallucis Flap**	**Medial Plantar Flap**	**Lateral Calcaneal Flap**
No of Cases	**11**	**9**	**7**	**5**	**2**	**5**	**2**	**3**	**1**
FUNCTIONAL ASSESSMENT									
Gait/ Stability	+	+	+	+	+	+	+	++	++
Sensation (Plantar)	+	+	++	++	++	-	+++	+++	+++
Movements (ankle & foot joints)	+	+	+	+	+	+	+	++	++

Donor area morbidity		+	+	-	-	-	++	-	-	-
Duration of return to work	Leg	4 Weeks	4 Weeks	4 Weeks	4 Weeks	4 Weeks	6 Weeks	4 Weeks	4 Weeks	4 Weeks
	Foot	6 Weeks	6 Weeks	6 Weeks	6 Weeks	6 Weeks	6 Weeks	6 Weeks	6 Weeks	6 Weeks

AESTHESIS

Colour	++	++	++	++	++	+	+	+++	++
Texture	++	++	+	+	+	+	+	+++	++
Contour	++	++	++	++	+	++	++	++	+++

FREE FLAPS USED FOR LEG & FOOT DEFECTS

	FREE ANTERO LATERAL THIGH FLAP	FREE LATISSIMUS DORSI MUSCLE FLAP & SSG	FREE GRACILIS MUSCLE FLAP & SSG	FREE TEMPEROPARITAL FASCIAL FLAP & SSG
No of patients	14	2	1	2
Gait/ Stability	++	++	++	+
Sensation (Plantar)	++	++	++	++
Movements (Ankle & Foot joints)	++	++	++	+++
Donor area morbidity	+	-	-	-

Return to work	8 Weeks	8 Weeks	8 Weeks	8 Weeks
Color	+	+	+	+
Texture	++	+	+	+
Contour	-	+	+	+++

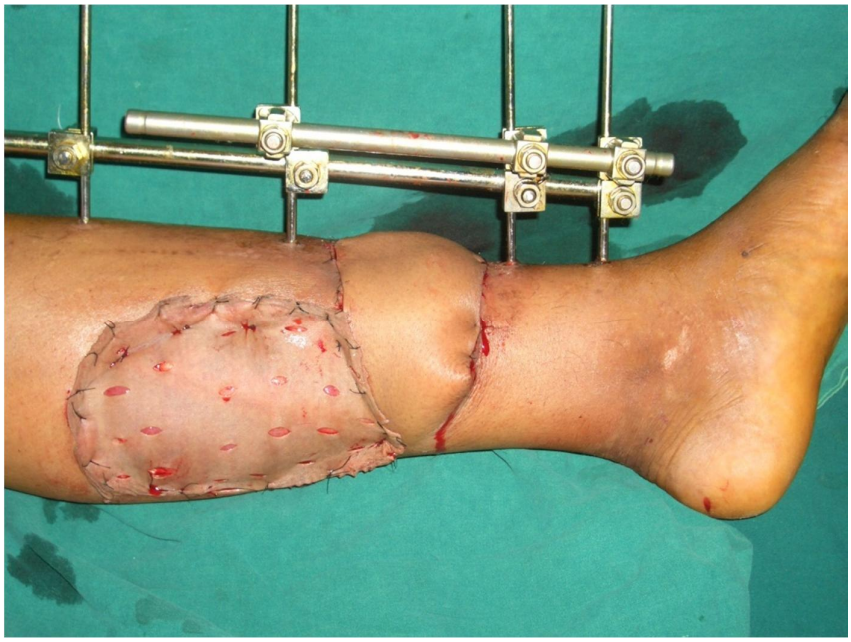
+ POOR

++ GOOD

+++ EXCELLANT

UPPER 1/3 DEFECT- GASTROCNEMIUS MUSCLE FLAP & SSG

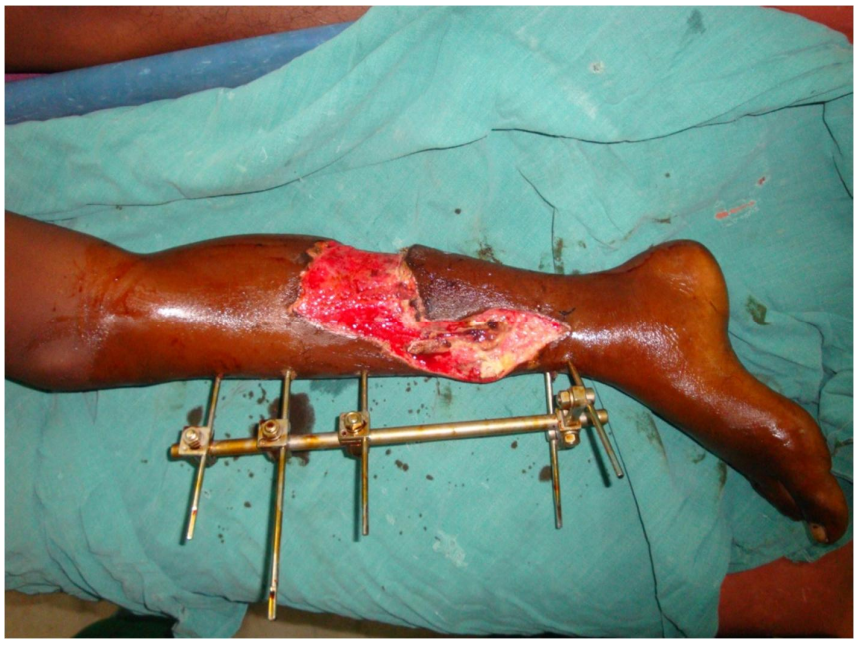
MIDDLE 1/3 LEG DEFECT- FASCIO CUTANEOUS FLAP



MIDDLE 1/3 DEFECT- SOLEUS MUSCLE FLAP & SSG

LOWER 1/3 DEFECT- FASCIO CUTANEOUS FLAP

LEG DEFGECT- FREE ANTEROLATERAL THIGH FLAP



HEEL DEFECT- REVERSE SURAL ARTERY FLAP

PERONEUS BREVIS MUSCLE FLAP & SSG

DISCUSSION OF RESULTS

Total number of patients with leg and foot defects came at our department during the 2 years study period were sixty four of which conventional flaps used for leg and foot defects were 45 and free flaps were 19. For leg defects 37 conventional flaps were used and 8 free flaps were used. For defects less than 5 cm size fascio cutaneous muscle flaps were used for leg defects. For larger defects more than 5 cm free anterio lateral thigh flaps were given.

For foot defects less than 5 cm size on the plantar and heel aspect 6 local flaps were used. For dorsal defects exposing tendons and bones two reverse sural flaps were used. For larger size more than 5 cm exposing bones and tendons 4 free muscle flaps and 5 anterolateral thigh flaps were used. For larger size more than 5 cm plantar defects 1 case of free muscle flap and 2 case of anterolateral thigh flaps were used.

Age and Sex Distribution:

The conventional flaps were used for 36 male patients and 5 female patients and 4 pediatric age group. Free flaps were used for 13 male patients, 1 female patient and 5 children.

COMPLICATION

The total flap losses were 3 out of 64 that included in this study. Distal part flap necrosis was seen in 5 free anterolateral thigh flaps that were used. The distal part flap necrosis was debrided and split thickness skin graft was applied to resurface the defects. The donor area morbidity was seen in 4 patients. Secondary SSG was done to manage the donor area in these patients as well as cases where flaps were totally lost after a period of dressing.

The plantar sensation was excellent in cases of local foot flaps. The gait and movements of foot were good in local flaps and muscle flaps. The dorsiflexion movements of foot were excellent in free temporoparietal fascial flaps and also in free muscle flap with SSG.

The colour match, texture and contour were excellent in local foot flaps. The colour and texture were good in anterolateral thigh flaps. The contour is maintained in free temporoparietal fascial flaps.

The duration of hospital stay for conventional flaps excluding cross leg flap and free flaps were two weeks. The duration for return of work was less in free flaps when compared to conventional flaps. The distal conventional flap i.e cross leg flap needs staged reconstruction and it required longer hospital stay.

The time duration taken for return of work was 4 weeks in conventional and 6 weeks for microvascular free flaps in leg defects. For foot defects the duration was 6 weeks in local flaps when compared to 8 weeks in free flaps.

The use of foot wear is acceptable easily in cases of free muscle flap and free fascial flap cases. The use of foot wear is difficult in bulky anterolateral thigh flaps.

CONCLUSION

Local flaps are the mainstay of reconstruction for leg and foot for smaller defects.

Local flaps give good results in functional as well as aesthesis. The duration of hospital stay is less and return to work is early for local flaps when compared to distant and free flaps.

Larger defects exposing vital structures for which local flaps unavailable, free flaps are the main modality of reconstructive option.

Free temporoparietal fascial flaps and free latissimus dorsi muscle flaps give good functional outcome and aesthesis for dorsum foot defects compared to bulky free anterolateral thigh flaps.

Early wound coverage within a week mitigates infection, less hospital stay and enhances productivity of individual.

Achievement of bipedal gait is earlier in sensate and less bulky flaps. The use of Doppler comes handy as far as designing local flaps.

The conventional flaps are mainly used for male patients with all age groups except distant flaps. The distant flaps are more suitable for paediatric age groups.

The free flaps are more used in paediatric and as well as younger age male patients.

The acceptance of foot wear is good in cases of local flaps, thin fascial and muscle flaps.

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PROFORMA

1. NAME :

2. AGE/SEX :

3. PS NO :

4. ADDRESS :

5. MOBILE NO :

6. OCCUPATION :

7. SOCIOECONOMIC STATUS :

8. DATE OF INJURY :

9. NATURE OF INJURY :

10. DATE OF SURGERY :

11. OTHER INJURIES :

12. OTHER CO MORBIDITIES :

13. PREOP XRAYS :

14. TIME AT WHICH MOBILISATION STARTED

15.WHETHER PATIENT ATTENDED PHYSIOTHERAPY OR NOT

16.ASSESSMENT

- GAIT ANALYSIS
- RANGE OF MOVEMENTS AT ANKLE, FOOT JOINTS,
- DONOR AREA MORBIDITY,
- RECONSTRUCTED AREA AESTHESIS- TEXTURE, COLOUR MATCH, CONTOUR.

MASTER CHART

CONVENTIONAL FLAPS

		Fasciocutaneous Flap	**Reverse Sural Flap**	**Soleus Muscle Flap**	**Gastrocnemius Flap**	**Peroneus Brevis Flap**	**Cross Leg Flap**	**Abductor Hallucis Muscle Flaps**	**Medial Plantar Flaps**	**Lateral Calcaneal**
Number of patients		**11**	**9**	**7**	**5**	**2**	**5**	**2**	**3**	**1**
Various sites										
Leg Defects	Upper 1/3	**4**	-	-	**5**	-	-	-	-	-
	Middle 1/3	**5**	-	**7**	-	-	-	-	-	-
	Lower 1/3	**2**	**5**	-	-	**2**	**3**	-	-	-
Foot Defects	Dorsum	-	**4**	-	-	-	**2**	-	-	-
	Plantar	-	-	-	-	-	-	**2**	**3**	**1**

		Fasciocutaneous Flap	**Reverse Sural Flap**	**Soleus Muscle Flap**	**Gastrocnemius Flap**	**Peroneus Brevis Flap**	**Cross Leg Flap**	**Abductor Hallucis Muscle Flaps**	**Medial Plantar Flaps**	**Lateral Calcaneal**	**Fasciocutaneous Flap**
Functional Assessment											
Gait		+	+	+	+	+	+	+	++	++	
Sensation		+	+	++	++	++	-	+++	+++	+++	
Movements		+	+	+	+	+	+	+	++	++	
Donor area morbidity		+	+	-	-	-	++	-	-	-	
Duration of return to work	**Leg**	4 Weeks	4 Weeks	4 Weeks	4 Weeks	4 Weeks	6 Weeks	4 Weeks	4 Weeks	4 Weeks	
	Foot	6 Weeks	6 Weeks	6 Weeks	6 Weeks	6 Weeks	6 Weeks	6 Weeks	6 Weeks	6 Weeks	

Aesthesis									
Colour	++	++	++	++	++	+	+	+++	++
Texture	++	++	+	+	+	+	+	+++	++
Contour	++	++	++	++	+	++	++	++	+++

FREE FLAPS

		FREE ALTF	FREE LATISSIMUS DORSI MUSCLE FLAP	FREE GRACILIS MUSCLE FLAP	FREE TEMPEROPARIETAL FASCIAL FLAP
Number of patients		14	2	1	2
Various sites					
Leg Defects		**8**	**-**	**-**	**-**
Foot Defects	Dorsum	**4**	**1**	**1**	**2**
	Plantar	**2**	**1**	**-**	**-**
Functional Assessment					
Gait		++	++	++	+
Sensation		++	++	++	++

Movements		++	++	++	+++
Donor area morbidity		+	-	-	-
Duration of return to work	**Leg**	8 Weeks	8 Weeks	8 Weeks	8 Weeks
	Foot	8 Weeks	8 Weeks	8 Weeks	8 Weeks
Aesthesis					
Colour		+	+	+	+
Texture		++	+	+	+
Contour		-	+	+	+++